The Influence of Environmental Temperature on the Incidence of Bleeding Peptic Ulcer

By MICHAEL T. HARRISON, M.B.(BELF.), M.R.C.P.
Formerly House Physician, Royal Victoria Hospital, Belfast

WHILE working as house physician in the Royal Victoria Hospital, Belfast, I was impressed by the large number of cases of hæmatemesis and/or melæna admitted to the wards during the month of November, 1955. This investigation was therefore undertaken, in the first place to determine whether the incidence of bleeding peptic ulcer varies at different times during the year. For this purpose, cases of bleeding peptic ulcer admitted to the wards of the Royal Victoria Hospital during the period 1946-1952 were collected from the records. Only those patients with a history of pain suggestive of ulceration, or with radiological or other evidence of an ulcer, were included. Cases of hæmatemesis or melæna associated with carcinoma of the stomach, cirrhosis, or other disease, and those with no evidence of peptic ulceration were not included. During this seven-year period, 548 cases of bleeding peptic ulcer were admitted to hospital. Of these, 292 were patients under 50 years of age, the other 256 being 50 or older. The date on which bleeding first occurred was noted in each case.

It is thought that these cases represent an unselected sample of all the cases of bleeding peptic ulcer in Belfast over this period, so far as the variables considered in this paper (time of year and environmental temperature), are concerned. Gastrointestinal bleeding is generally regarded as an emergency requiring admission to hospital, and the great majority of such patients in this area are admitted either to the Royal Victoria Hospital or to the City Hospital, Belfast, without selection.

RESULTS.

Seasonal Distribution. The numbers of cases occurring in each season of the year over the seven-year period were compared, the results being shown in Table I. In this table, and in Tables 2 and 3, χ^2 was obtained on the basis of a null hypothesis; the expected number of cases in each age group was calculated by dividing the total number by 4, 12, and 7 respectively, in Tables 1, 2, and 3.

Monthly Distribution. The numbers of cases occurring in each month over the seven-year period are shown in Table 2 and in Fig. 1.

Daily Distribution. The total numbers of cases occurring on each day of the week were next calculated, as shown in Table 3.

As expected, the largest number of cases of bleeding peptic ulcer occurred in the winter months (December-February). The number of cases occurring in the summer months (June-August), was only slightly less: 141 as against 157, while considerably fewer cases (118) occurred between March and May. Considering the incidence in the older age group alone, there is still less variation from one season to another. The differences are not statistically significant at the 5% level. Furthermore, there was no single month in which a strikingly larger total number of cases occurred than in any other month. However, there is a significant difference in monthly incidence of bleeding in the older age group (Table 2), the incidence falling in the summer months, rising suddenly in November, and remaining high during the winter (Fig. 1).

TABLE 1

SEASONAL DISTRIBUTION OF ADMISSIONS.

SEASON		AGE GROUP IN YEARS	
	Total	Under 50	50 and over
December-February	157	85	72
March-May	118	56	62
June-August	141	82	59
September-November	132	69	63
TOTAL	548	292	256
χ^2	5.9	7.3	1.5
D.F.	3	3	3
Probability	$P > 0.1$	$0.1 > P > 0.05$	$P > 0.1$

TABLE 2

MONTHLY DISTRIBUTION OF ADMISSIONS.

MONTH		AGE GROUP IN YEARS	
	Total	Under 50	50 and over
January	48	22	26
February	53	32	21
March	55	23	32
April	34	14	20
May	29	19	10
June	51	27	24
July	41	24	17
August	49	31	18
September	39	20	19
October	39	26	13
November	54	23	31
December	56	31	25
TOTAL	548	292	256
χ^2	18.95	13.2	22.8
D.F.	11	11	11
Probability	$0.1 > P > 0.05$	$P > 0.1$	$0.01 < P < 0.02$

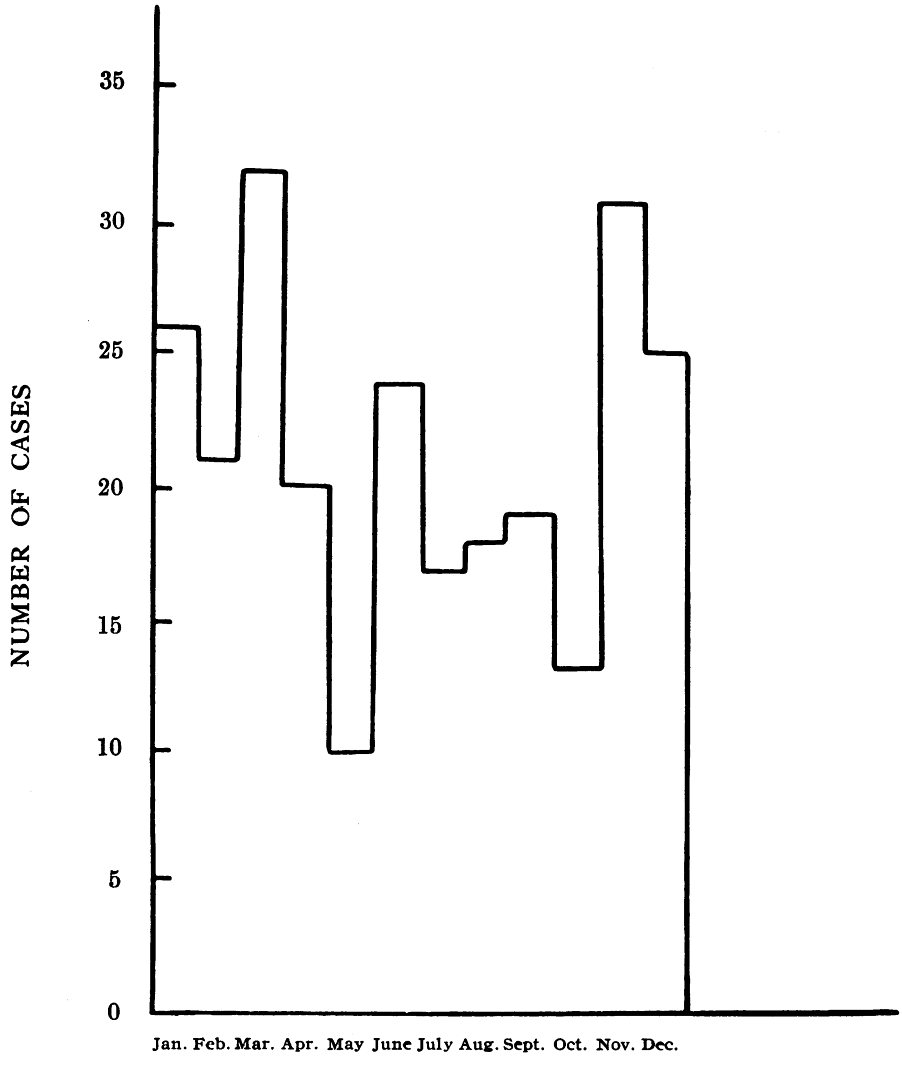

Fig. 1
Monthly Distribution of Bleeding Peptic Ulcer in subjects over 50 years of age.

TABLE 3

DAILY DISTRIBUTION OF ADMISSIONS.

DAY	Total		Age Group in Years: Under 50		50 and over
Monday	77	...	42	...	35
Tuesday	73	...	46	...	27
Wednesday	85	...	44	...	41
Thursday	87	...	40	...	47
Friday	86	...	48	...	38
Saturday	73	...	40	...	33
Sunday	67	...	32	...	35
TOTAL	548	...	292	...	256
χ^2	4.7	...	3.9	...	6.5
D.F.	6	...	6	...	6
Probability	$P > 0.1$	...	$P > 0.1$	...	$P > 0.1$

Among the possible factors responsible for this significant variation, the influence of environmental temperature seemed important, and this was next studied. From records kept at the meteorological station of Queen's University, Belfast, the maximum and minimum daily temperatures for each day of the period 1946-1952 were obtained. The temperatures and temperature ranges existing at approximately the time that each case of bleeding occurred were compared with the incidence of this complication in order to determine whether any of them correlated significantly.

The following temperatures were studied:—

(a) The maximum temperature on the day of bleeding.

(b) The 24-hour temperature range over the day of bleeding (i.e., the difference between maximum and minimum temperatures on that day).

(c) The minimum temperature on the day of bleeding.

(d) The maximum temperature on the day before bleeding occurred.

(e) The temperature range on the day before bleeding occurred.

(f) The difference between the maximum temperature on the day when bleeding occurred and the maximum temperature of the preceding day.

(g) The difference between the lowest and highest temperatures of each two-day period, the day on which bleeding occurred being the second of the two days.

In all these analyses, the procedure was similar, in that the temperatures or temperature differences were arranged in groups, each covering a range of 5 degrees Fahrenheit. The number of days in which the relevant temperatures lay within each 5 degree group was counted, each day of the 7-year period being allotted to its appropriate group. The relevant temperatures on each day on which a case of bleeding occurred was noted, and also the temperature on the day preceding each case. Thus the number of cases falling within each temperature group was counted.

These results are shown in Table 4. In this and the subsequent tables, the expected values were derived on the basis of a null hypothesis, assuming that the total number of cases and the total number of days were divided between the temperature groups in the same ratio. For example, in a group comprising 100 days, the expected number of cases would be

$$\frac{100 \times \text{Total number of cases.}}{7 \times 365}$$

TABLE 4

COMPARISON OF OBSERVED WITH EXPECTED DISTRIBUTIONS, ACCORDING TO VARIOUS TEMPERATURES.

TEMPERATURE	Age Group in Years: Under 50 χ^2	D.F.	Probability	50 and over χ^2	D.F.	Probability
Maximum temperature on day of bleeding - -	12.35	7	0.1 > P > 0.05	16.95	7	0.01 > P > 0.02
Temperature range on day of bleeding - -	3.6	4	P > 0.1	9.8	4	0.02 > P > 0.05
Minimum temperature on day of bleeding - -	1.0	6	P > 0.1	8.9	6	P > 0.1
Maximum temperature on preceding day - -	12.6	7	0.1 > P > 0.05	13.1	7	0.1 > P > 0.05
Temperature range on preceding day - -	3.0	4	P > 0.1	5.9	4	P > 0.1
Difference in maximum temperature between day of bleeding and preceding day - -	0.5	3	P > 0.1	2.4	3	P > 0.1
Difference between maximum and minimum temperature of two-day period - - -	3.0	4	P > 0.1	7.9	4	0.1 > P > 0.05

Table 4 shows that of all the temperatures studied, only two correlated significantly with the incidence of bleeding: the maximum temperature and the temperature range on the day when bleeding occurred. These relationships are shown in detail in Tables 5 and 6, and in Figs. 2 and 3.

DISCUSSION.

A significant difference has been shown in monthly incidence of bleeding peptic ulcer in subjects over 50 years of age. There is an irregular incidence from

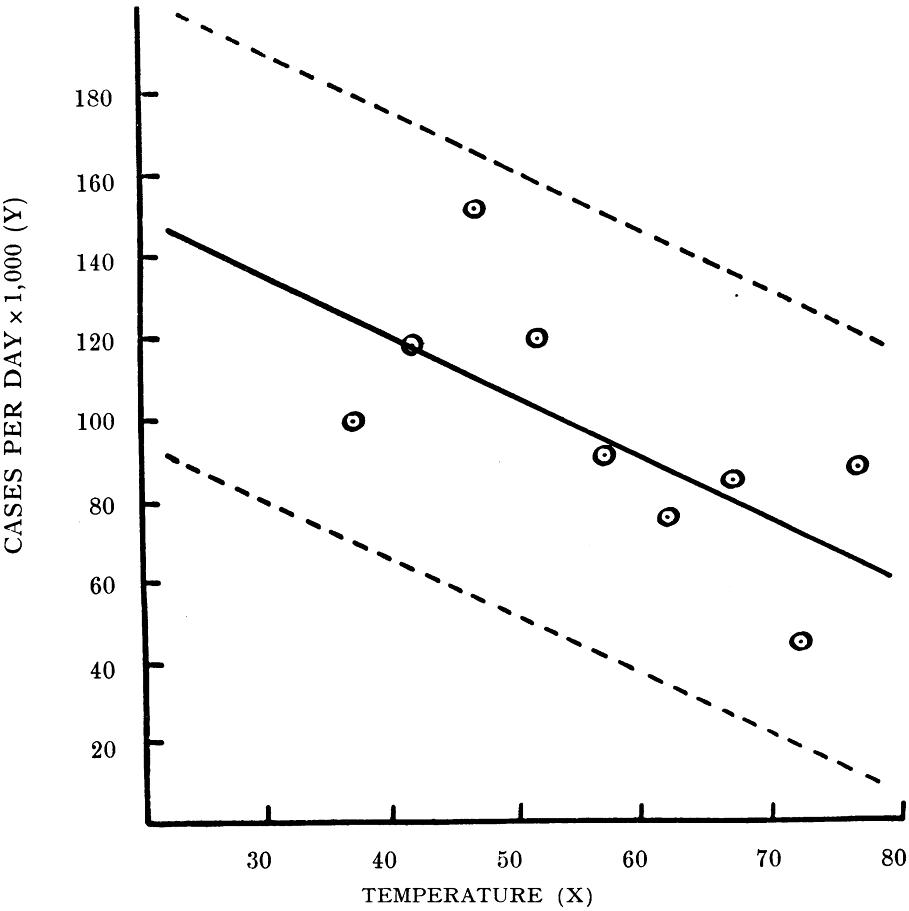

Fig. 2

Regression of number of cases of bleeding in subjects over 50 years of age on maximum daily temperature. The solid line represents the regression line, and the dotted lines $\pm$ 2 S.D. from regression.

$Y = 180.5 - 1.5\ X$. S.E. of regression coefficient $= 0.6$.
S.D. from regression $= 23.4$. $0.02 < P < 0.05$.

January to June, a sudden fall in July, which persists until October, and a sudden rise in November and December (Fig. 1). These findings are similar to, although not identical with, those of Lewison (1950), who showed in patients admitted to Johns Hopkins Hospital between 1928 and 1946, the incidence of bleeding peptic ulcer was lowest in June and July, and highest in October. Duggan (1956), analysing admissions to the Royal Newcastle Hospital, New South Wales, from 1949 to 1954, showed a low incidence in the midyear, and a peak in December and January.

It is of interest to compare the findings of Illingworth (1953), with regard to perforated peptic ulcer. The incidence of this complication is roughly constant each month from January to July, then falls abruptly with the holdiay period till November, and rises to a high peak in December. In none of these other series was a differentiation made between age groups, and in the present series the significant variation is seen to affect the group over 50 years alone, and not the younger group.

The incidence of bleeding does not vary with the day of the week. As a complication of peptic ulcer, therefore, hæmorrhage differs from perforation in that the incidence of the latter is least on Sunday and Monday, intermediate during the midweek, and reaches a high peak on Friday and Saturday (Illingworth, 1953). Illingworth also investigated the variation in incidence of perforation with the hour of the day, and found 4-6 p.m. to be the time of greatest incidence. A comparable study of bleeding peptic ulcer could not be made here, as the exact times of hæmorrhage were not regularly entered in the case records.

Table 4 shows the effect of maximum daily temperature on the incidence of bleeding. It is seen that this temperature is a significant factor in the older age group (50 and over), in that a low maximum temperature favours a high incidence of bleeding from an ulcer. Fig. 2 shows the high degree of correlation between maximum temperature and incidence of bleeding in this group. In the group under 50 this relationship is not evident. This finding is consistent with the variation in monthly distribution of hæmorrhage in the older age group, which

TABLE 5

COMPARISON OF OBSERVED WITH EXPECTED DISTRIBUTION, ACCORDING TO MAXIMUM TEMPERATURE.

MAXIMUM TEMPERATURE (°F.)	AGE GROUP IN YEARS: Under 50 Observed	Under 50 Expected	50 and over Observed	50 and over Expected
30-34	—	1.15	2	1.0
35-39	8	11.5	10	10.1
40-44	35	30.2	31	26.4
45-49	46	36.6	48	32.0
50-54	45	56.2	56	49.2
55-59	41	47.1	37	41.1
60-64	69	56.7	37	49.6
65-69	38	35.4	26	30.9
70-74	5	13.05	5	11.4
75-79	5	4.0	3	3.5
80-84	—	0.6	1	0.5
χ^2	12.35		16.95	
D.F.	7		7	
Probability	$0.1 > P > 0.05$		$0.01 < P < 0.02$	

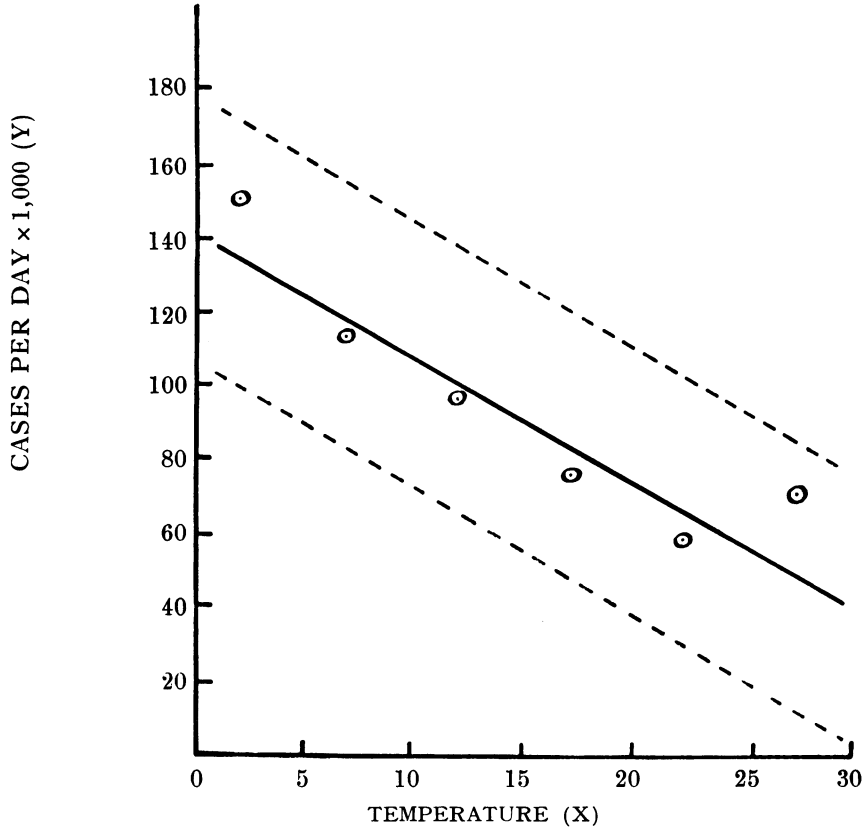

Fig. 3

Regression of number of cases of bleeding in subjects over 50 years of age on the 24-hour temperature range. The solid line represents the regression line, and the dotted line $\pm$ 2 S.D. from regression.

$Y = 144 - 3.4\ X$.
S.D. from regression = 12.75.
S.E. of regression coefficient = 0.6.
$P < 0.01$.

was found to be least in the summer months and high in November and December. Now the maximum temperature on a given day probably reflects the mean temperature of the part of the day during which an individual would be exposed to outdoor conditions. This assumption is based on the fact that the maximum temperature usually occurs about the middle of the day or in the early afternoon, when people are working, whereas the minimum temperature often occurs at night when people are indoors. Therefore a cold day appears to predispose to bleeding from a peptic ulcer in a subject over 50 years of age.

Table 5 and Fig. 3 show that a correlation also exists between the daily temperature range and the incidence of bleeding in the older age group. A small range in temperature is associated with a significantly higher incidence of bleeding than a large range. This is consistent with the fact that on days with a low maximum temperature there is likely to be a smaller range in temperature during that day than on days when the maximum temperature is high.

Table 6 shows that the minimum temperature, the mean temperature of the preceding day, and the change in temperature from one day to the next, do not affect the incidence of bleeding peptic ulcer in either age group. The significant feature of these results, then, is that in a subject with peptic ulcer over 50 years of age, bleeding is more likely to occur on a cold day than on a warm one. Exposure to cold may therefore be a precipitating factor in the etiology of bleeding peptic ulcer. In subjects under 50 years of age with peptic ulcer, cold does not affect the incidence of bleeding significantly.

TABLE 6

COMPARISON OF OBSERVED WITH EXPECTED DISTRIBUTION, ACCORDING TO 24-HOUR TEMPERATURE RANGE.

24-HOUR RANGE (°F.)	AGE GROUP IN YEARS: Under 50 Observed	Under 50 Expected	50 and over Observed	50 and over Expected
0-4	15	14.8	20	13.2
5-9	89	86.5	88	77.1
10-14	105	97.9	85	87.3
15-19	49	51.3	35	45.7
20-24	7	13.3	7	11.9
25-29	1	1.6	1	1.4
30-34	–	0.1	–	0.1
χ^2	3.6		9.8	
D.F.	4		4	
Probability	$P > 0.1$		$0.02 < P < 0.05$	

The precipitation by cold of bleeding from a peptic ulcer may be an effect of the stress resulting from exposure. While the mechanism of the effects of stress is unknown, increased liberation of hydrocortisone by the adrenal glands may be an important factor. It is well known that peptic ulcers may bleed or perforate during treatment with cortisone or corticotrophin, although Sandweiss (1954) suggests that such ulcers are usually acute and may occur whether the patient had a past history of ulcer or not.

Crohn and Shwartzman (1937), noted the frequency of gastro-intestinal bleeding following respiratory tract infection, and suggested that this was a manifestation of the Shwartzman phenomenon. The ulcer crater becomes secondarily invaded by bacteria, which induce a lasting state of reactivity in the surrounding tissues. During a subsequent infection, circulating products of bacteria cause necrosis and hæmorrhage in the reactive ulcer site. Thus the higher incidence of bleeding peptic ulcer during the winter months might, in part, be explained by the prevalence of respiratory tract infection at this time.

It is possible that there is a physiological cold pressor response of the gastric and duodenal blood vessels, which results in vasoconstriction. Atheromatous vessels would not be able to constrict to the same extent as normal vessels, so that the vasoconstriction produced by exposure to cold might protect a young subject with peptic ulcer and normal blood vessels from bleeding, but would not take place in an older subject with atheromatous vessels.

Beaumont (1833), in his famous observations on a subject with a gastric fistula, found that while a humid atmosphere was associated with a slightly lower temperature inside the stomach than a dry one, there was no correlation between the environmental temperature over a wide range and the temperature inside the stomach. Nor did he mention any change in appearance of the interior of the stomach with either intragastric or environmental temperature variation.

Another factor which may be significant is that more hot food and hot drinks are consumed on cold days, resulting in trauma to the stomach mucosa and increased blood supply to its walls.

The consumption of aspirin is another possible factor, although there is no definite evidence to show whether this is really greater on cold days. Waterson (1955), has shown aspirin to be a cause of hæmorrhage due to acute gastric erosion, and it is known to increase the discomfort of many patients suffering from peptic ulcer. Whether aspirin has a more destructive effect on gastric mucosa of subjects over 50 years of age than under is unknown, but older people suffer more from cold, and may consume a greater quantity of aspirin to alleviate their sufferings from "rheumatics" and other complaints which seem to be aggravated by cold weather.

Summary.

The maximum daily environmental temperature has been shown to be significantly correlated with the incidence of hæmorrhage from peptic ulcer in subjects over 50 years of age. A low maximum temperature is associated with a higher incidence of hæmorrhage on the same day. The maximum day temperature probably reflects the mean temperature during which an individual is exposed to outdoor conditions. In subjects over 50 years of age the 24-hour temperature range is also a significant factor, a small range being associated with a high incidence of bleeding. There is also a significant variation in monthly incidence of this complication in older subjects, not unlike that observed with perforated peptic ulcer, although less striking. Possible reasons for these findings are discussed.

The minimum 24-hour temperature and the variations in temperature during the day preceding the onset of hæmorrhage do not significantly influence the incidence of this complication.

I wish to thank Professor G. M. Bull for his constant advice and encouragement, Dr. E. A. Cheeseman for statistical advice, and Mrs. J. McCabe and Mr. J. D. Merrett for help in compiling the tables.

References.

Beaumont, W. (1833). *Experiments and Observations on the Gastic Juice and the Physiology of Digestion.* Plattsburg, F. P. Allen.

Crohn, B. B., Shwartzman, G. (1937). *Amer. J. Digest. Dis.*, **4**, 705.

Duggan, J. M. (1956). *Med. J. Austral.*, **2**, 941.

Illingworth, C. F. W. (1953). *Peptic Ulcer.* Livingstone, Edinburgh.

Lewison, E. F. (1950). *Internat. Abstr. Surg.*, **90**, 1.

Sandweiss, D. J. (1954). *Gastroenterol.*, **27**, 604.

Waterson, A. P. (1955). *Brit. med. J.*, **2**, 1531.

PERNICIOUS ANÆMIA SURVEY.

The College of General Practitioners is mapping the incidence of pernicious anæmia in the United Kingdom. Members and Associates of the College have already been notified, and other doctors have also provided data. The work is based on information supplied by doctors about the incidence of pernicious anæmia in their own practices. Much more information will be required before all areas are satisfactorily covered.

This notice is an appeal to all doctors in general practice in the United Kingdom to contribute data, so that the survey may be a success. The information required is simple and covers only four particulars:

(1) Number of patients of all ages in the practice.
(2) Number of cases of pernicious anæmia at present under treatment in the practice.
(3) Was the diagnosis made locally or elsewhere?
(4) Nature of practice—whether urban, semi-urban or rural.

Partnerships should be treated as a single practice. In a practice where there are many visitors, only data about permanent residents is required. Nil returns are especially important, to prevent an over-estimate of the incidence of the disease. Comments and enquiries are welcome. Professor L. J. Witts, M.D., F.R.C.P., has kindly consented to act as consultant adviser for this investigation.

It is emphasised that all details about practices will be regarded as strictly confidential. Information under the four headings mentioned above should be sent to **Dr. E. Scott, Suomi, Westwell, Ashford, Kent,** who is acting as Recorder for the College in this investigation. No further information is required from those who have already written.

The local officers of the College of General Practitioners have asked the Journal to publish the above notice, and they invite all practitioners to co-operate in this important survey.